The colour potentials of SSA-containing mortar

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THE COLOUR POTENTIALS OF SSA-CONTAINING MORTAR

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Abstract

This paper reports an experimental study of aesthetical qualities of mortar containing sewage sludge ash (SSA). SSA is the residue produced at water treatment plants where incineration of the sludge is applied in order to decrease volume and to prevent pathogens from spreading. Today SSA is with a few exceptions landfilled.

The purpose of the experiments was to examine the influence of SSA on strength and colour of mortar samples. SSA was ground in 6 different time intervals and added to mortar mixes by replacing 20% of the cement. An additional purpose was to examine the possibilities to influence the colours and texture of the hardened mortar by using paper cuttings in the production of the samples. The experiments showed that a colour scale can be developed from ground SSA, and that paper may provide different textural qualities when it is used in combination with other form materials.

Keywords: Sewage sludge ash, colour potentials, mortar, textures.

1 Introduction

As cement production is responsible for app. 5 - 8% of the total global CO_2 emission (Scrivner & Notat 2011) the advantage of replacing cement with a secondary resource such as SSA would seem obvious. Several studies (Cyr et al. 2007) have investigated the possibilities to utilize SSA as a supplementary cementitious material (SCM) with the potential of lowering the environmental impact of the cement production. The focus has mainly been on the chemical, mechanical properties and environmental consequences related to the use of SSA in cement based materials (Chen et al. 2013). These studies documented that the compressive strength normally decreases when cement partly is replaced by SSA. Conversely, the process of grinding SSA has been shown to improve the compressive strength of SSA- containing mortar (Donatello et al. 2010).

Some SSA have a distinct red colour due to chemical precipitation of phosphorus in wastewater treatment plants by iron, and replacing cement by such SSA can affect the colour of concrete and may challenge the traditional comprehension of concrete. Thus, the aim of this study was to examine the colour development of hardened mortar samples when ground SSA was added the mix by replacing partly the cement.

2 Experimental framework

This study included hands-on experiments for an investigation of: 1) the effect ground SSA had on the colour of the mortar samples and, 2) the possibilities to use simple paper cuttings as a method to provide different textural qualities- rough and smooth surfaces.

An iron-rich SSA from Avedøre Spildevandscenter, BIOFOS in Denmark was ground in 6 different time intervals ranging from 0 – 10 min, and added to a mortar mixes by replacing 20% of cement. The SSA was ground to obtain increasing fineness and larger specific surfaces areas of the SSA particles. The basic recipe used for the mortar samples used 75 % sand, 25% binder and a water/binder ratio of 0.5. The form materials which were used for mould production were film faced plywood, and for the paper cuttings a lining paper for walls was used.

3 Result and discussion

The experiments revealed that the colour of the SSA-containing mortar intensified as the time interval of the grinding process increased. Each of the 6 steps within the time interval 0 – 10 min provided an additional colour tone and generated a colour scale consisting of mortar samples ranging from greyish to a more saturated red brown colour (fig.1)**.**

The plain form materials - the film faced plywood and the lining paper, generated diverse textural qualities in both rough and smooth surfaces. The rough and smooth surfaces highlighted the shades and tones of the colour differently and provided a possibility to create patterns on the surface of the mortar samples (fig.2).

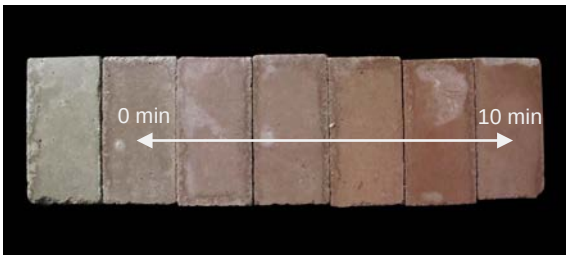

Fig.1 Colour scale of moisturized mortar samples

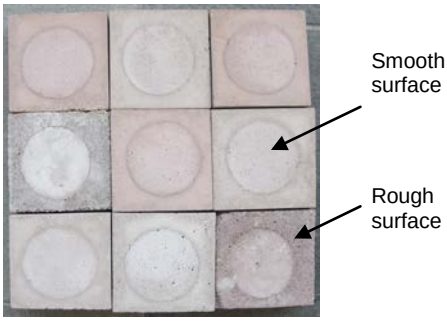

Fig.2 Accentuation of colour tones displayed by the difference of rough and smooth surfaces

The variability of SSA challenges it's suitability as SCM in cement based material. Nevertheless, Scrivener & Nonat 2011 advocate for the necessity to adjust future demands for cement by using locally available materials, and to develop on the basis of a scientific approach new SCM and cement types in order to produce sustainable cement based materials.

Empirical, initial testing of new materials such as SSA does not establish profound understandings of reactions on micro level and predictions of long term material performances at macro scale. Such testing will, however, often confront existing theoretical knowledge, pose new questions and unfold material properties, not perceived by a parametric model such as the aesthetical quality of a colour.

SSA shows potential as a secondary resource for colouring concrete, and if the aesthetical aspects such as colour are taken into account at an early stage, it could challenge a general idea that concrete is a grey, and in some views, a drab material.

4 Conclusions

This study revealed that SSA shows potential as a secondary resource for colouring concrete. A colour scale can be developed when different time intervals are applied to the process of miling SSA.

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